Integrated Intelligent Operations for Safer More Cost Effective Offshore Facilities

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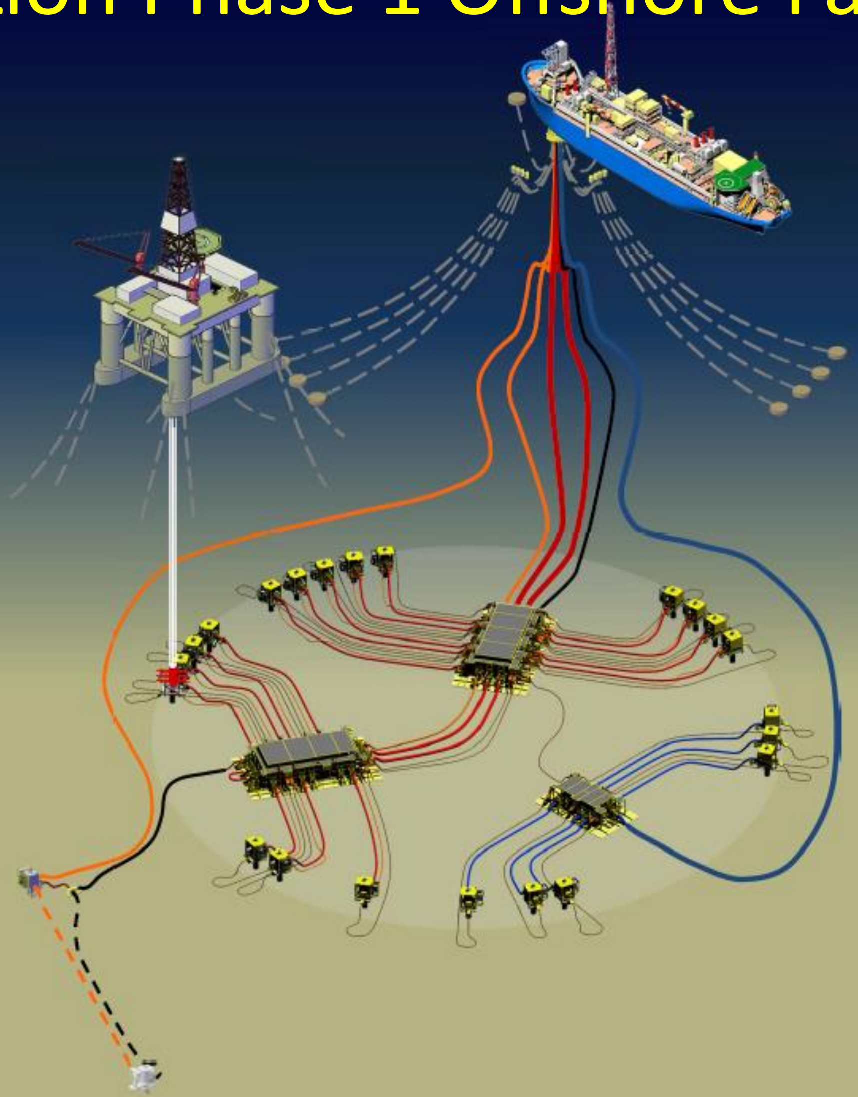
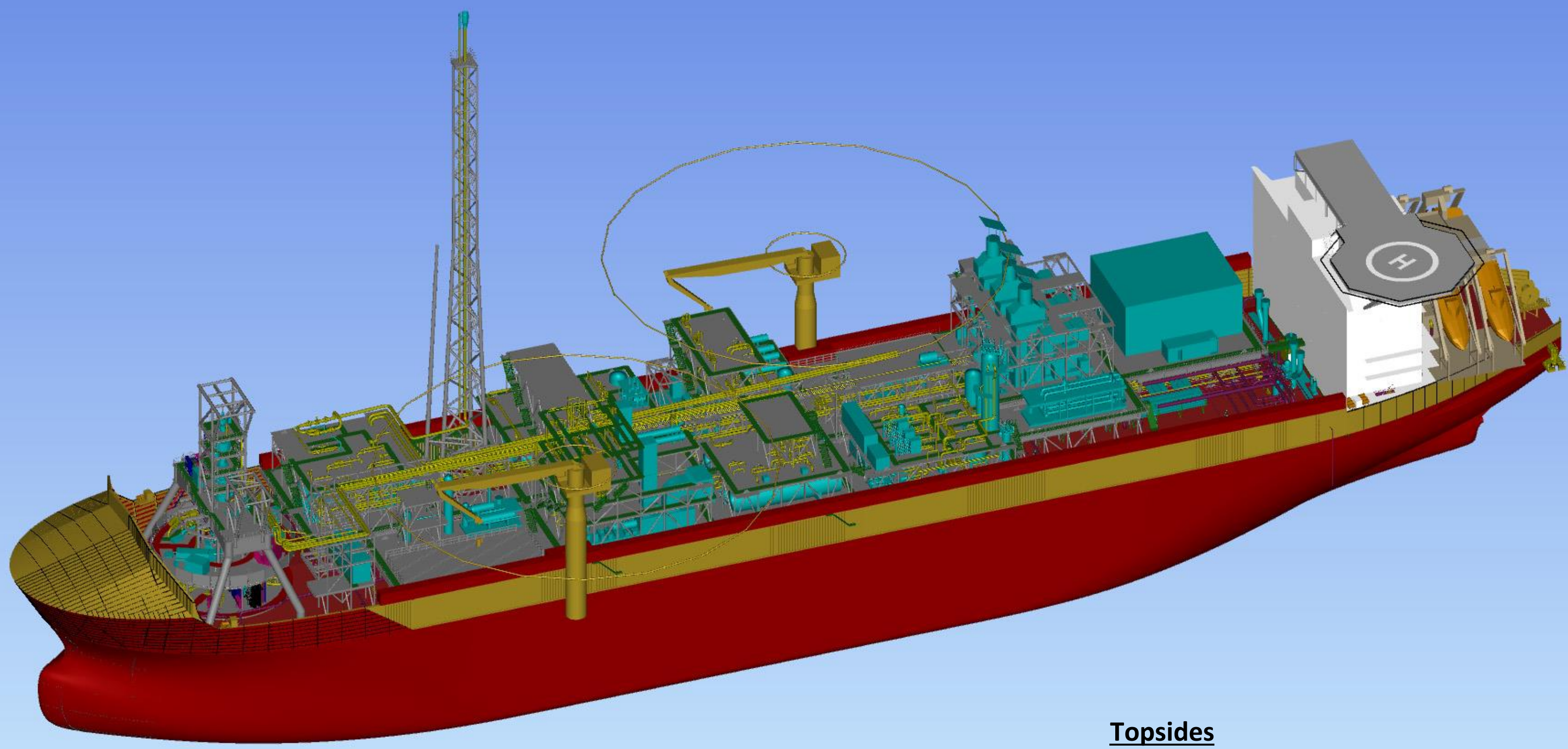
PremierOil

Sea Lion Phase 1 Offshore Facilities



Sea Lion FPSO: 120 beds capacity, core crew of 52 men, higher peaks during maintenance campaigns – can we reduce core and maintenance manning whilst improving safety and operational performance?



<u>Topsides</u>

150 Packaged Equipment Assemblies
200 Control Valves
850 Instruments
2500 Manual Valves

Offshore Facilities – Operational Areas

Subsurface

- Rock
- Reservoir Fluids
- Production Wells
- Water Injection Wells
- Gas Wells
- Completions
- Gas Lift
- ESP
- Hydraulic Pumps
- Wellheads
- Trees
- Chokes
- Chemical Injection
- Instrumentation
- Control Systems

Subsea

- Well Jumpers
- Electric / Hydraulic Flying Leads
- Connectors
- Manifolds
- Flowlines
- Risers
- Valves
- Metering
- Pumps
- Compression
- Umbilicals
- Chemical Injection
- Instrumentation
- Control Systems

Offshore Facility

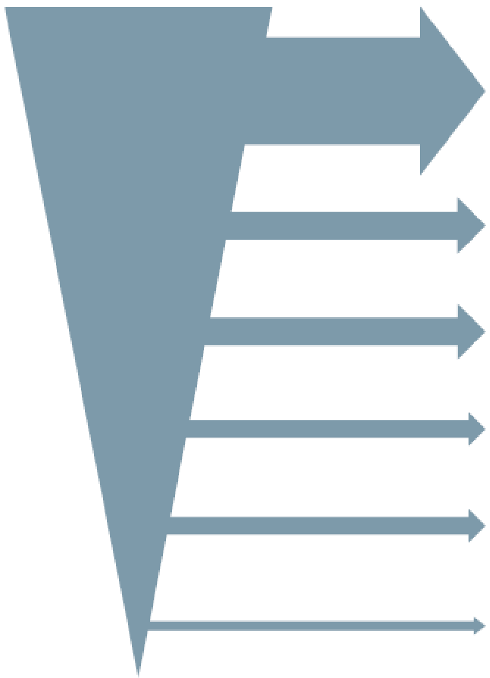
- Valves
- Swivels
- Piping Systems
- Power Generation
- Heat / Cooling Systems
- Separation Systems
- Water Treatment
- Gas Treatment
- Gas Compression
- Pumps
- Flare / Vent Relief Systems
- Closed / Open Drains
- Chemical Injection
- Instrumentation
- Control Systems

All these areas generate tremendous amounts of Data able to be used in **Integrated Intelligent Operations (IIO)**

One of the challenges:

99 percent of data collected from 30,000 sensors on an oil rig was lost before reaching operational decision makers

100%
~30,000 sensors
gathering data



Data capture	~40% of all data is never stored; remainder is stored locally offshore
Infrastructure	Only ~1% of data can be streamed onshore for daily use
Data management	Data cannot be accessed in real time, enabling only "ad hoc" analysis
Analytics	Reporting is limited to a few metrics, which are monitored in retrospect
Deployment	No interface is in place to enable real-time analytics to capture offshore data
People and processes	Maintenance is still conducted at manufacturer-recommended intervals

<1%
of data used for
decision making

SOURCE: McKinsey Global Institute analysis

What are Integrated Intelligent Operations (IIO)?

Reliability

- Quality Specifications
- Defect Elimination
- Robust Equipment (high MTBF)
- Simplify Systems
- Open Standards
- Flawless Start-up
- Performance Monitoring
- Remote Diagnostics
- Descriptive / Predictive / Prescriptive / Cognitive Analytics

Operability

- Minimal Complexity
- Total Operational Hours
- Metering & Sampling
- Logistics & Integrated Planning
- Multi-skilled Operators
- Training & Competence
- Remote Operations
- Production Modelling
- Scenario Planning
- Preventative Operations

Maintainability

- Efficient Processes
- Corrosion Resistance / Material Selection
- Non-intrusive Inspections / Robotics
- Access from grade
- Plug & Play Equipment
- Maintenance Management System
- Risk Based Maintenance
- Preventative / Corrective Maintenance

"Integration of people, process, and technology to make and execute better decisions quicker" *(Ref. Statoil)*

How can IIO make an offshore facility safer and more cost effective?

Technical Safety

- Systematic reduction in manning levels offshore;
- Eliminate routine presence of personnel in hazardous areas unless performing required asset integrity tasks;
- Better collaboration on key decisions with onshore expert support teams,
- Better assurance of safety and environmental critical elements and systems;

Value

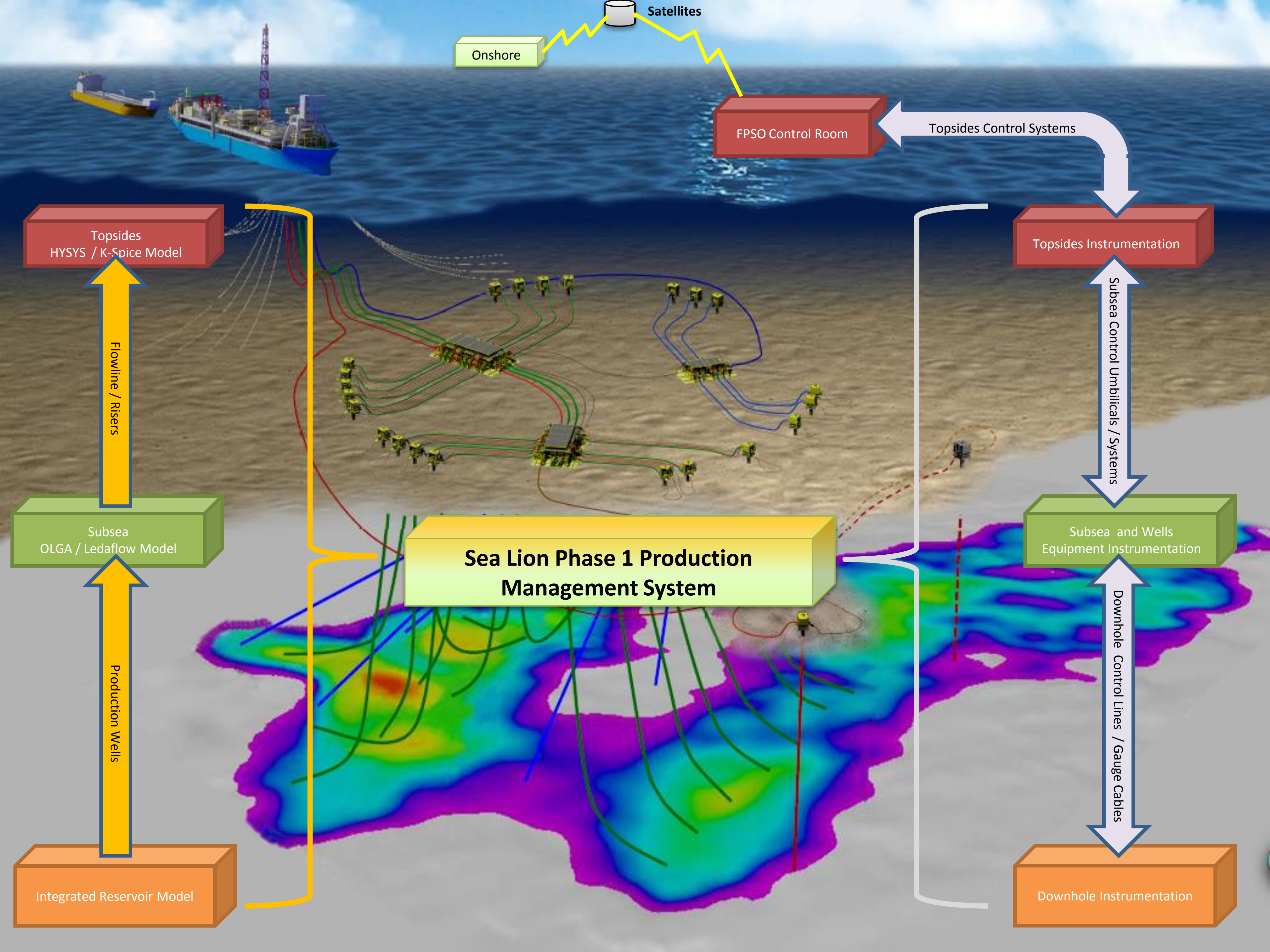
- More efficient production, so more peak barrels of oil;
- Less unplanned shutdowns and higher availability so accelerated production;
- Extended field life so longer cost effective production;
- Better planning of offshore tasks, so less production interruptions;

Life Cycle Costs

- Simpler facilities would save CAPEX;
- Lower OPEX with reduced offshore manning;
- Better sparing decisions (type, number, location, logistics, tools, personnel competencies);
- More effective maintenance spend.

Subsurface Resource

- The subsurface resource is hydrocarbon molecules (oil, condensate, and/or gas) contained in some kind of rock and reservoir;
- **Our challenge is to efficiently recover this resource through safe, cost effective facilities (CAPEX) and operations (OPEX);**
- An offshore development includes wells (oil and/or gas production, water injection, and gas injection) that need to be managed efficiently to maximise production in a safe manner;
- **Continuous streams of Data from the subsurface is available ("reservoir surveillance"), either from downhole instrumentation or from seabed facilities sensors:**
  - Using this Data, operators can make decisions to optimise the production by adjusting well parameters including surface chokes thereby changing the drawdown (differential pressure driving well fluids from the reservoir into the wellbore);
  - Wells with gas lift or artificial lift like ESPs or hydraulic pumps can be adjusted to improve production;
  - Water or gas injection wells can be tuned for better pressure support to the reservoir or sweep of the resource towards the producing wells;
  - Well fluid data can be used to optimise chemical injection systems and costs;
- **All this Data should be used in Production Management Systems to model, monitor, and decide how to best manage the resource**.



Satellites
Onshore
FPSO Control Room
Topsides Control Systems
Topsides
HYSYS / K-Spice Model
Topsides Instrumentation
Flowline / Risers
Subsea Control Umbilicals / Systems
Subsea
OLGA / Ledaflow Model
Sea Lion Phase 1 Production
Management System
Subsea and Wells
Equipment Instrumentation
Production Wells
Downhole Control Lines / Gauge Cables
Integrated Reservoir Model
Downhole Instrumentation

Offshore Facilities Topsides

- These facilities typically comprise piping, valves, process vessels, safety and control systems, rotating equipment (pumps, compressors, power generation), water handling and treatment, gas handing and treatment, metering, accommodation, and utilities;
- The surrounding environment should be monitored for metocean conditions (wind, wave, current, swells, directionality and magnitudes) as data that affects vessel performance;
- Every piece of equipment and system requires to be operated and maintained – each with a specific performance envelope and limits for safe operations;
- For a typical piece of process equipment we already monitor inlet and outlet pressures (ΔP), temperatures (ΔT), levels, flow rates, speed, vibrations, valve torque values, etc.;
- **Real time monitoring of data with stream analytics will enhance detection of anomalies or events that require attention from offshore personnel (due to latency issues) or onshore personnel (for specialist input or "health care" provider attention);**

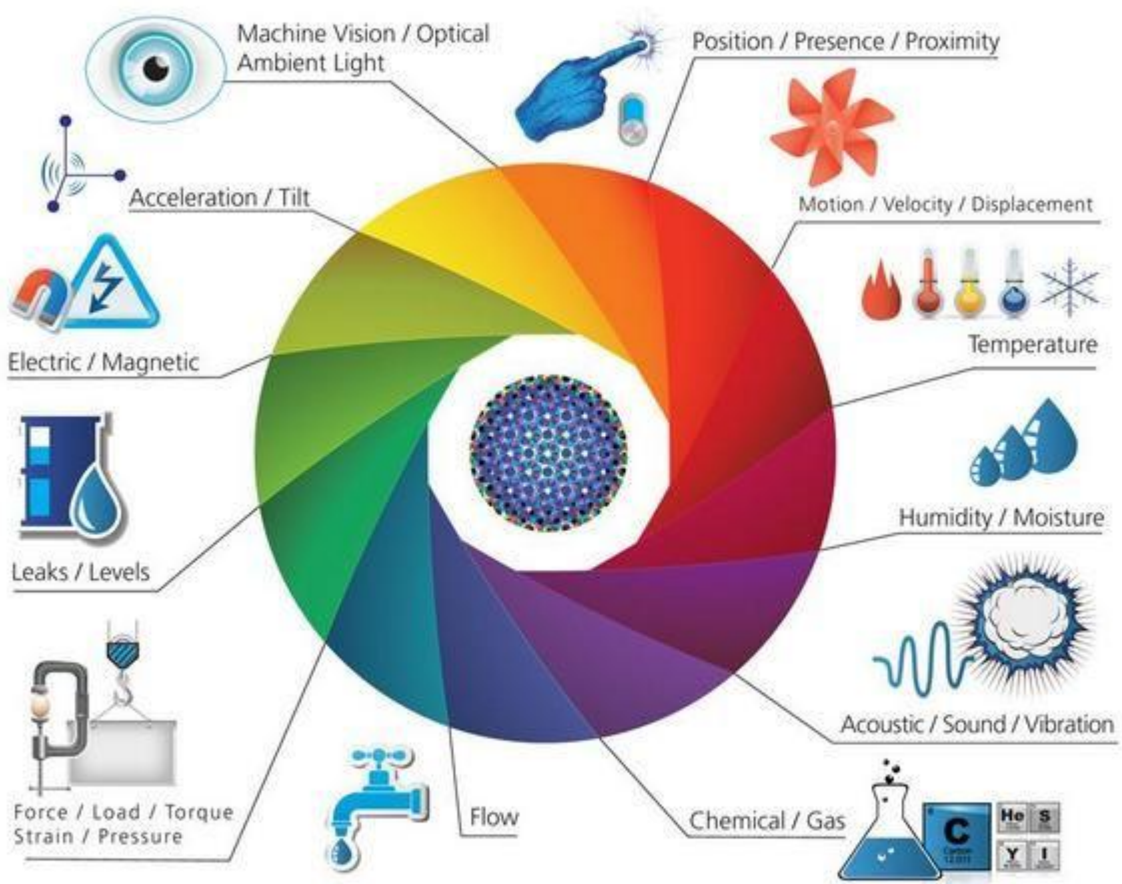
"One study found that 86% of maintenance is either reactive (too late) or preventive (unnecessary). Best practice is 40% reactive, with a shift to predictive/ proactive maintenance. … Remote diagnostics help alleviate unneeded trips to the field. As many as 35% of these trips are for routine checks, 28% are for non-existing problems, 20% are for calibration shifts, 6% are for "zero off," 6% for plugged lines, and 4% are actually failed instruments. That's mostly ghost chasing – going out to the field and checking things that were working" *(Ref. Emerson)*

Offshore Facilities ICSS

- An Integrated Control and Safety System (ICSS) onboard the facility will help gather the data, monitor, and control the production equipment and systems;
- There are already significant numbers of sensors / instruments already on the production equipment and systems feeding data into the ICSS;
- During Detailed Design, a full production engineering simulator ("Digital Twin") can be programmed to model and test the safety and control systems logic settings and capabilities, to train Operations personnel, and to simulate ranges of various process parameters;
- Reducing control loops that might otherwise be moved to manual control offshore and improving the tuning and optimization of control loops that may be liable to demonstrate excessive process variability are good outcomes of pre-operations simulation work;
- The onboard ICSS systems are split between the topsides system and the subsea system, both linked into the facility control room and from there onwards to onshore monitoring locations;
- Both the topsides and subsea systems require a substantial amount of computer hardware to capture the data, to store it, to perform onboard "stream" analytics, and to segregate key portions of the data for subsequent transmission via satellite;
- Key challenges are (1) where to store types of data (offshore and/or onshore)?; (2) how to communicate this data?; (3) information security?; and (4) how to integrate the data?

Sensors → Data

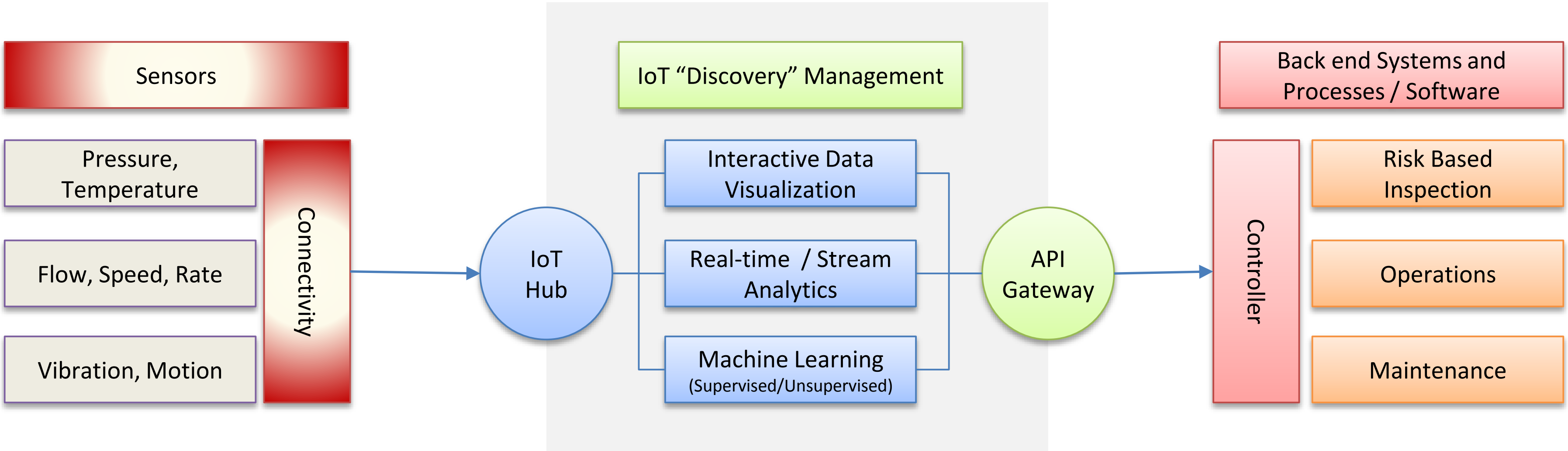
- Sensors can be almost anything needed to gather a particular kind of relevant Data in specific conditions:



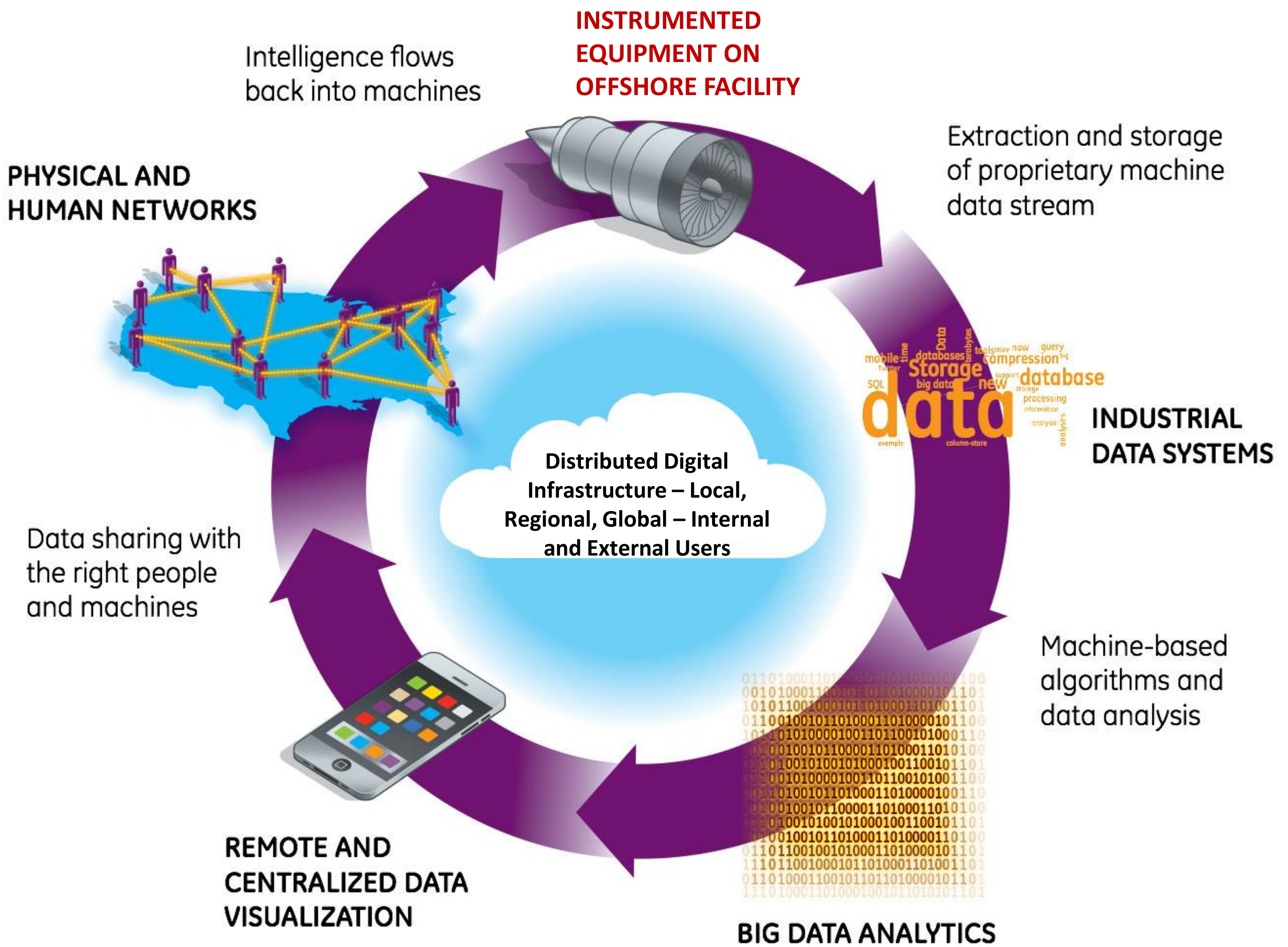
(Ref: Postscapes / Harbor Research)

Data Architecture

- Internet of Things (IoT): "an ecosystem of technologies monitoring the status of physical objects, capturing meaningful data, and communicating that information through networks to software applications"
- Enabling technologies:
  - Sensors on physical objects ("smart objects")
  - Communications (Wired and/or Wireless) with appropriate levels of security, bandwidth, and interconnection and/or separation of various systems
  - M2M (Machine to Machine communication):
    - Wired: Ethernet / RS485 (serial communication system) / Power Line Comms (IEEE P1901.2 PLC)
    - Wireless: IEEE 802.15.4 / RFID Tags / NFC chips (to uniquely identify smart objects)
    - Internet Protocol version 6 (IPv6) (to be able to provide unique IP addresses to all the smart objects)
  - Digital Storage ("Storage of Everything" (SoE)) and distribution (onboard and remote)
  - Application Programming Interfaces (API's)

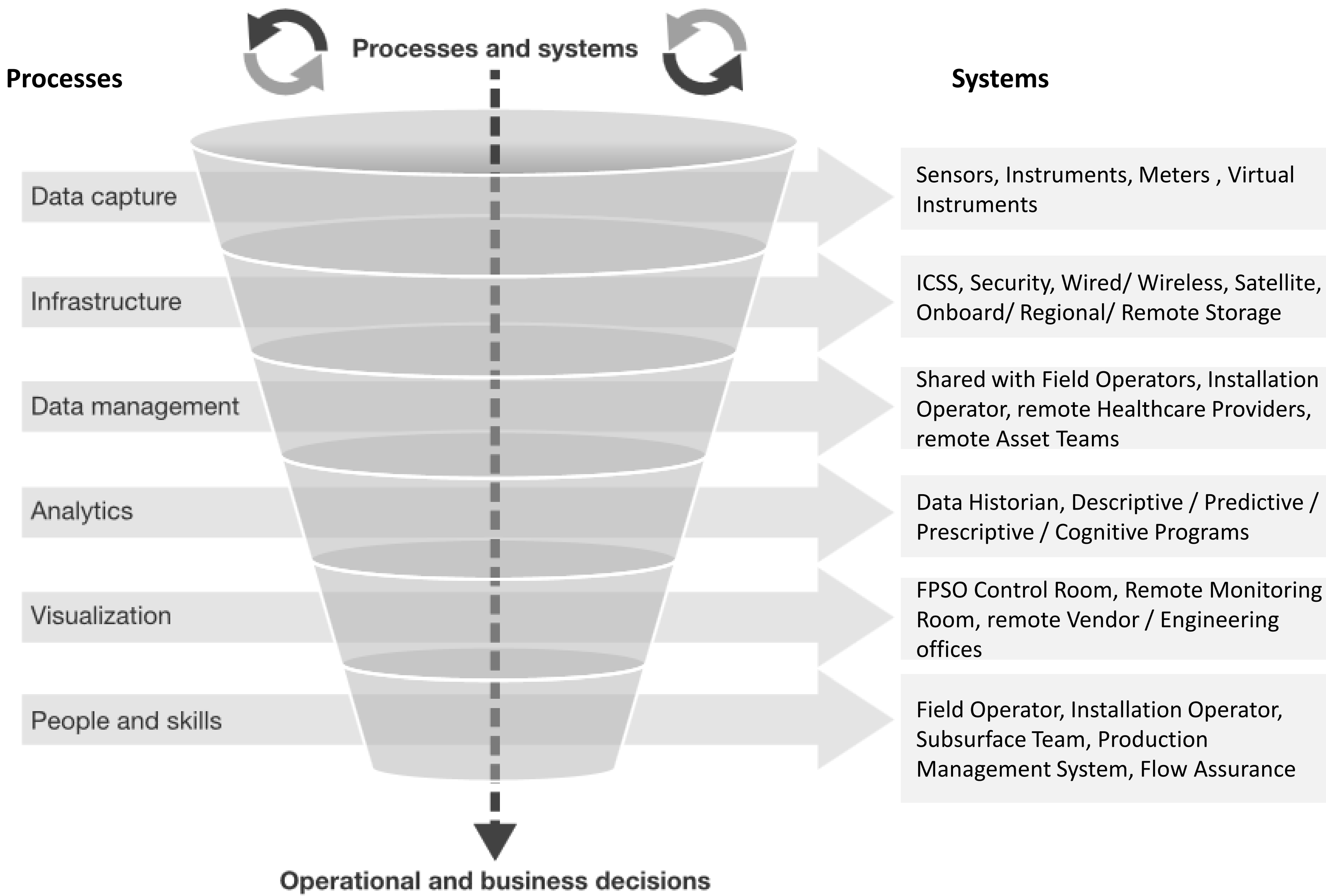


Data Cycle ("Value Loop")



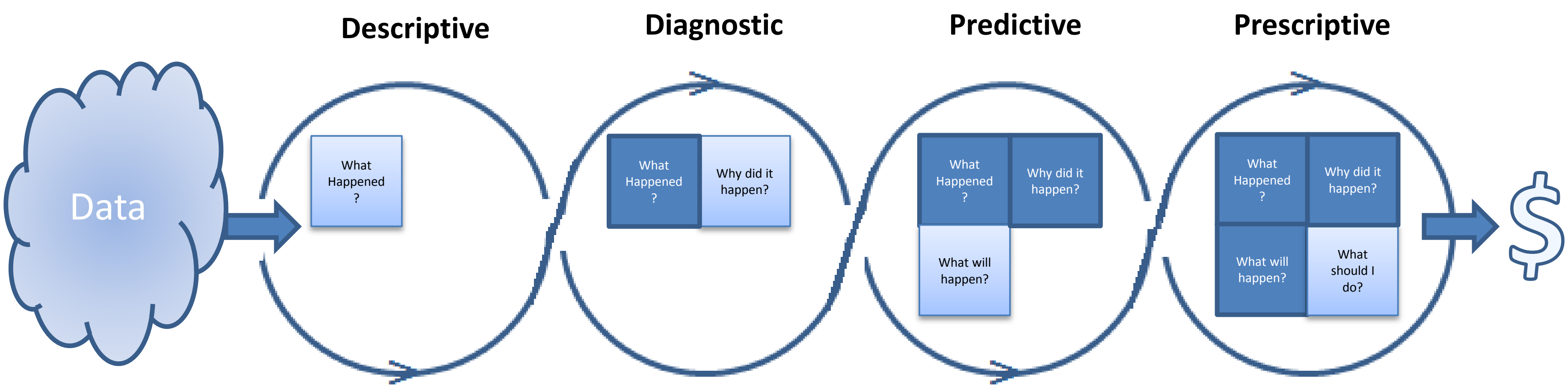
(Ref: GE)

What should we do with relevant Data?



Analytics

- The Data captured should be analysed to extract information and value in several analytical steps as shown in this graphic:



- Another type of analytics is Cognitive Analytics if there is a suitable database of relevant operational data to review and analyse – once operations begin, this database should be populated and appropriate software can cognitively analyse the data to determine what is “normal”, what is an “anomaly”, and to help predict future asset failures so that effective asset integrity programs can be implemented to improve availability and reduce unplanned failures.

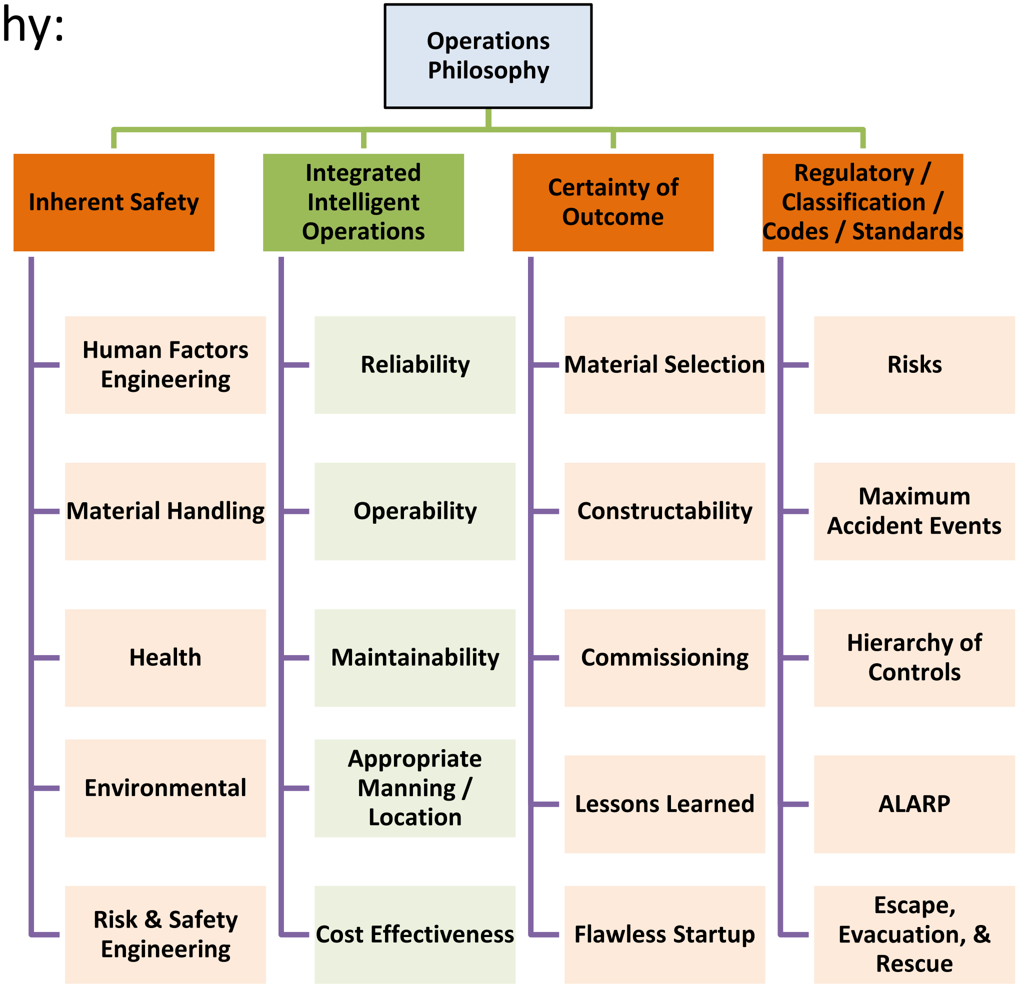
We should locate appropriate support personnel <u>onshore</u> … safer, more cost effective … we can support the crew onboard the remote offshore facility with better technical expertise, analytics, and daily task planning and execution assistance.

Safer, more cost effective performance through…

- **Production Surveillance** – Continuous monitoring of production at well and facility levels, identifying underperformance and steps needed to resolve performance issues;
- **Production Excellence** – Production Management System to help best management wells and reservoir production; proactively managing the production instead of just reacting;
- **Operational Data** – Data capture, integration, and visualisation to preserve and analyse, to utilise in applications, to compare historical and real-time values, and to make better informed decisions;
- **Process Safety** – Effective alarm management, continuous monitoring and validation of safety systems; systematic assurance of safety and environmental critical elements and processes; “no surprises”;
- **Equipment Effectiveness** – Continuous condition monitoring of equipment and production systems with respect to normal performance envelopes to improve availability; systematic assurance of control instrumentation; input to integrity management programs and preventative maintenance activities;
- **Operational Performance** – utilising personnel in the remote offshore facility and back in the support office to perform the tasks best suited to each location and to facilitate collaboration; managing information at the field, asset, and enterprise levels to mitigate risks and pursue opportunities.

Conclusion

IIO allows moving away from previous operational norms to make facilities safer, more cost effective, and more efficient within the framework of an effective Operations Philosophy:



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